BIO-DIVERSITY

Definition: All biologic entities want to diverse. It is a contracted form of biologic diversity. It can be defined as it is a global composite of genes, species and ecosystem or variety or variability of biologic species.

*Variability: Potential of variation present as inherent property of biologic animals.

**Gene---Cells---Tissue---Organs---Individuals---Population---Community---Ecosystem

Levels of Bio-diversity:

There are three different levels of biodiversity

a. Genetic Diversity

b. Species Diversity

c. Habitat/Ecosystem Diversity

GENETIC DIVERSITY:

Genetic diversity is the variety present at the level of genes. Genes, made of DNA (right), are the building blocks that determine how an organism will develop and what its traits and abilities will be. This level of diversity can differ by alleles (different variants of the same gene, such as blue or brown eyes), by entire genes (which determine traits, such as the ability to metabolize a particular substance), or by units larger than genes such as chromosomal structure. Genetic diversity can be measured at many different levels, including population, species, community, and biome. Which level is used depends upon what is being examined and why, but genetic diversity is important at each of these levels.

Why is it Important?

The amount of diversity at the genetic level is important because it represents the raw material for evolution and adaptation. More genetic diversity in a species or population means a greater ability for some of the individuals in it to adapt to changes in the environment. Less diversity leads to uniformity, which is a problem in the long term, as it is unlikely that any individual in the population would be able to adapt to changing conditions. As an example, modern agricultural practices use monocultures, which are large cultures of genetically identical plants. This is an advantage when is comes to growing and harvesting crops, but can be a problem when a disease or parasite attacks the field, as every plant in the field will be susceptible. Monocultures are also unable to deal well with changing conditions.

Why is it related to?

Within species, genetic diversity often increases with environmental variability, which can be expected. If the environment often changes, different genes will have an advantage at different times or places. In this situation genetic diversity remains high because many genes are in the population at any given time. If the environment didn't change, then the small number of genes that had an advantage in that unchanging environment would spread at the cost of the others, causing a drop in genetic diversity

In communities, it can increase with the diversity of species. How much it increases depends not only on the number of species, but also on how closely related the species are. Species that are closely related (*e.g.* two species of maple) have similar genetic structures and makeup and therefore do not contribute much additional genetic diversity. These closely-related species will contribute to genetic diversity in the community less than more remotely-related species (*e.g.* a maple and a pine) would.

An increase in species diversity can also affect the genetic diversity, and do so differently at different levels. If there are many species, the genetic diversity at that level will be larger than when there are fewer species. On the other hand, genetic diversity within each species can decrease. This can happen if the large number of species means so much competition that each species must be extremely specialized, such as only eating a single type of food. If they are so specialized, this specialization will lead to little genetic diversity within any of the species.

SPECIES DIVERSITY:

Biodiversity studies typically focus on species. They do so not because species diversity is more important than the other two types, but because species diversity is easier to work with. Species are relatively easy to identify by eye in the field, whereas genetic diversity (above) requires laboratories, time and resources to identify and ecosystem diversity (see below) needs many complex measurements to be taken over a long period of time. Species are also easier to conceptualize and have been the basis of much of the evolutionary and ecological research that biodiversity draws on.

Species are well known and are distinct units of diversity. Each species can be considered to have a particular "role" in the ecosystem, so the addition or loss of single species may have consequences for the system as a whole. Conservation efforts often begin with the recognition that a species is endangered in some way, and a change in the number of species in an ecosystem is a readily obtainable and easily comprehensible measure of how healthy the ecosystem is

Habitat/Ecosystem Diversity: Different kinds of habitat present. So, species diversity has different levels.

1. Within habitat:

a. α-diversity : Diversity found in a small homogeneous habitat is called α-diversity.

b. Point Diversity: Diversity found in particular point of a small homogeneous habitat is called point diversity

So, within habitat diversity= α-diversity + point diversity.

2. Between habitat:

a. β-diversity: Diversity found between two different homogeneous habitats is called β-diversity. The graeter the difference or turnover of species between habitat, the greater the β-diversity.

3. γ-diversity : Diversity found across a large region is called γ-diversity.

*Region: If there is no major special barrier for dispersal.

**δ-diversity: If two regions are separated by a barrier and then diversity is measured of two large region, it is called δ-diversity.

Regional Diversity: Local diversity occurs when input of new species in the large area and extinction of species already present in that habitat.

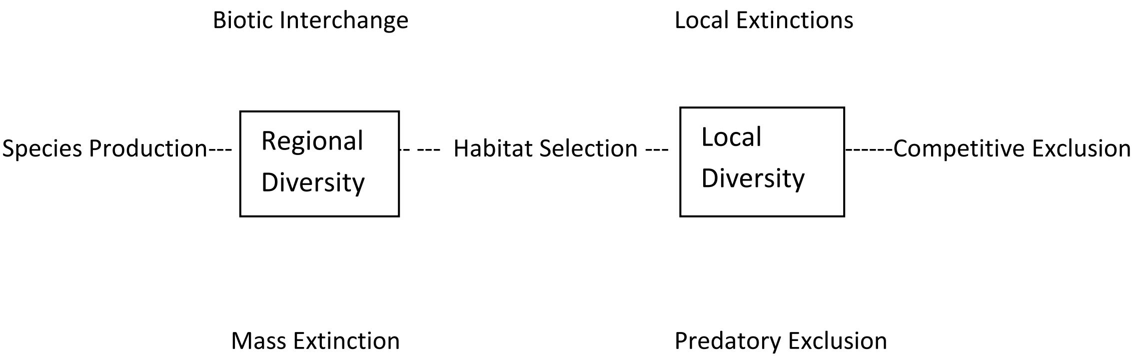
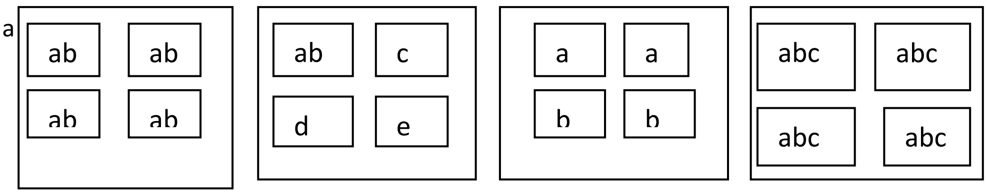


Fig.: Factors affecting regional and local species diversity

** Numbers of species are increased at the regional level by speciation and immigration (Biotic interchange). Ecological interactions influence diversity at local levels. Each local contains a small sample of the total regional diversity because species are habitat specialists. Thus habitat selection connects regional and local diversity.

Relationship between α, β and γ Diversity : $\beta = \gamma / \alpha$

*Average α –diversity must be calculated when species are different in different patch of a region.



a. b. c. d.

Calculate α, β and γ Diversity:

For a: α-diversity is 2 (because 2 species present in the four patches); β-diversity is 1 and γ diversity is 2 (because 2 species spread over the region)

For b: α-diversity is 1.25 (Average α-diversity= No. of species / No. of habitat patches= 5/4=1.25)

β-diversity is 4 and γ diversity is 5.

For c: α-diversity is 0.5 (Here also average α-diversity should be calculate) ; β-diversity is 4 and γ diversity is 2

For d: α-diversity is 3 (because 3 species present in the four patches); β-diversity is 1 and γ diversity is 3 (because 3 species spread over the region)

* a. and b. have different γ diversities, but the same β-diversity, indicating little species turnover occur in those areas

** Greater γ diversity revealed greater habitat specialisation.

ECOLOGICAL RELEASE: island species often attain greater densities than their mainland counterparts, a phenomenon called Density Compensation (Crowell,1962) = No. of individual/ unit area.

Also they expand into habitats that would normally be filled by other species on the mainland, a phenomenon is called habitat expansion (Mac Arthur et al, 1972; Wright, 1980).

So, Ecological Release = Density compensation + Habitat expansion.

For example,

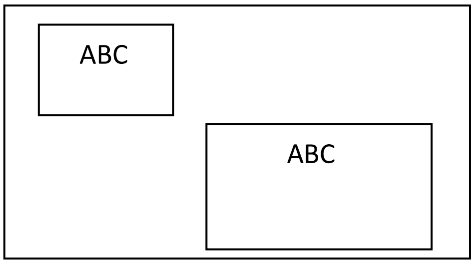


Fig. A. 1. Where patches are unequal. But climatic and environmental situation is similar, only area is varying

2. ABC species are present on either patches.

3. But difference is the density which is more in smaller area than large area.

4. In small area species ABC are fully distributed throughout the small area. This is called habitat expansion.

5. But in large area, species ABC restricted only in a part of whole area. So, ecological release is less.

Island	Regional Diversity	A-Diversity	Habitat/species	Relative abundance/.species
Panama	135	30.2	2.01	5.93
St. Kitts	20	11.9	5.35	31.45

Table: Comparison of land bird between Panama and St. Kitts.

In Panama 135 sp. of birds are present but in St. Kitts 20 types of birds present. So, species diversity is more in Panama but Habitat/ sp. in Panama is low than St. Kitts, that means Habitat expansion is taken place in St. Kitts. So, Ecological release is much in St. Kitts.

ISLAND BIOGEOGRAPHY MODEL (Mac ARTHUR & WILSON, 1992):

Islands can serve almost as a laboratory for the study of biogeography. The biota of an island is simpler than that of a continental area, and the interactions are easier to understand.

There are three types of islands:

a. Islands that were originally part of a nearby continent, but were separated by rising sea levels (land-bridge islands).

b. Islands that are part of a volcanic island arc.

c. Seamount chains which formed over geological "hotspots".

The types of islands have different characteristic flora and fauna. Islands formed by isolation from continents would have a biota which would be a subset of that on the continent. It would have changed, however, as the result of independent evolution and extinction. The biota of island arcs and hotspot island chains originally arrived by trans-ocean dispersal. In both cases, several islands exist at one time, creating the possibility for inter-island dispersal and a more complex pattern of evolutionary change. Dispersal to islands is typically by a sweepstakes route,. The dispersing organisms share adaptations that allow them to reach the island, rather than adaptations allowing them to live there once they reach it. This is one factor that restricts the diversity of life on islands.

Island populations are more likely to go extinct than those on mainland, for several reasons:

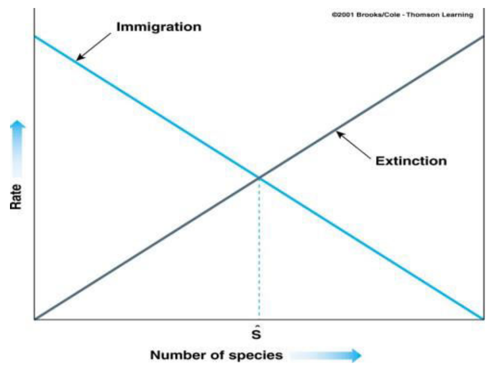
1. Populations are typically smaller.

2. They have less genetic diversity.

3. They were not originally adapted to the island habitat.

Islands are typically depauperate in species richness relative to mainland areas of comparable size. Originally, this was explained by a *nonequilibrium* theory of island biogeography which stated that islands are depauperate because they have not had sufficient time to accumulate species by immigration.

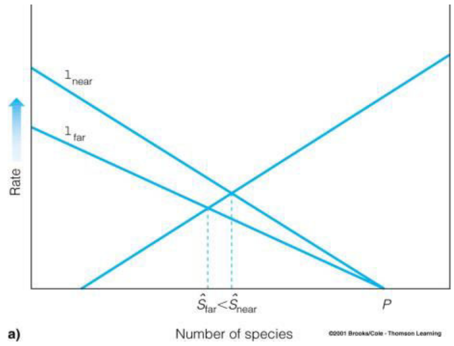
In 1963, Robert MacArthur and E.O. Wilson presented a new hypothesis to explain patterns of species richness on islands. Their equilibrium theory of island biogeography proposed that the lower number of species on islands was not the result of insufficient time, but rather the result of an equilibrium process peculiar to all islands. The theory is based on the idea that, at any given time, the number of species on an island is the result of a balance between two processes: extinction and colonization.



When a new island forms, species begin to colonize. As more and more species accumulate, the colonization rate begins to decline. The extinction rate, on the other hand, begins to increase with increasing diversity. At some point, the two processes balance each other, and the number of species on the island should stabilize. This equilibrium number is known as S.

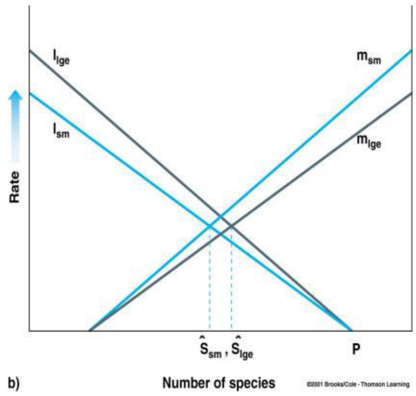
The equilibrium theory can also be used to explain the effect of size and distance on the number of species found on islands.

Consider two islands of similar sizes but different distances from the mainland pool. Since extinction rates are a function of the available resources and should be related to the size of the island, we would expect them to be similar on the two islands. Colonization rates, however, should be greater for the island near the mainland than for the more distant island.



This should result in a difference in the equilibrium number of species, with $N_{near} > N_{far}$.

A similar argument can be used to explain the effect of island size. If two islands are of relatively equal distance from the mainland, we can expect colonization rates to be similar. Extinction rates, however, should be greater on the smaller island. Therefore, we expect a higher equilibrium number of species on the large island.



So, the two approaches (nonequilibrium and equilibrium) make very different predictions about the nature of island species.

1. The equilibrium theory predicts that the number of species will not change over time. The nonequilibrium theory predicts that the number of species should increase with time.

The equilibrium species predicts that, although the number of species will remain relatively constant, the actual makeup of those species will change.

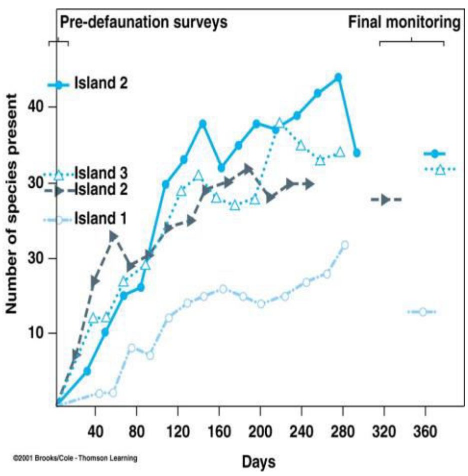
Several datasets have been developed that support the equilibrium theory. Jared Diamond looked at bird species on the Channel Islands off the California coast.

TABLE 12.2
Total Number of Bird Species on Selected Channel Islands

Island	1917	1967
Los Coronados	11	11
San Nicolas	11	11
San Clemente	28	24
Santa Catalina	30	34
Santa Barbara	10	6

Data from Diamond 1969.

In 1969, E.O. Wilson and Daniel Simberloff conducted an experiment employing mangrove islets in the Florida Keys. They surveyed a series of islands of differing sizes and distances from shore, concentrating on the arthropod fauna found on the islands. Then, they defaunated the islands by enclosing them in plastic and pumping in methyl bromide to kill all the arthropods. They found that species increased for a while, then reached an asymptote approximately equal to the original number. But the makeup of the species had changed



Following the publication of the theory, a number of other studies were conducted to examine its validity. A study on plant species on a group of islands off Britain showed that, in that case, the effect of size was indirect. Large islands had a greater degree of habitat heterogeneity, and therefore greater diversity.

In 1883, There was a small volcanic island Krakatoa (between Sumatra and Java). 15% of the total island diminished under sea. The rest has no flora, fauna, covered by volcanic lava.

After 25 years, 100 species of plant and 13 land bird species were already resting there. After 14 years, 16 species were added by immigration but 2 lost (extinction). After another 14 years, same no of species were present (27 species) but 5 added and 5 diminished. It means the process of immigration and extinction continues to the equilibrium level.

THREATS OF BIODIVERSITY: human and Nature induced rarity and rarity imposed by

a. Overexploitation

b. Habitat disruption

c. Introduction of species and

d. Genetic problems

Pattern, process, and consequences of rarity

What causes rarity? The answer to that question, or at least the endeavor to answer it, has been analyzed and debated since Darwin (1859) who suggested that rarity was a compulsory precursor to extinction. Contrary to popular belief, rarity is the norm rather than the exception (Preston 1948), yet identifying why some species are common and others are not has been an ongoing challenge. Current definition of rarity, however, has largely been attributed to Rabinowitz (1981) who identified seven forms of rarity based on dichotomies of distribution, habitat specificity, and abundance (Figure 1). This categorization illustrates the divergence from a rigid and "monolithic" state of rarity to a more flexible and informative schema. Kruckeberg and Rabinowitz later (1985) limit their examination to the ecological and evolutionary attributes of a single form of rarity—narrow endemics, or constantly sparse and geographically restricted taxa. Like Griggs (1940), Rabinowitz was puzzled by sparse species, particularly those that do not seem to have a favored habitat and occur over a large range, but in low abundances. However, in contrast to earlier suppositions made by Griggs (1940), Rabinowitz and Rapp (1981) found rare prairie grasses to be competitively superior to common grasses. Therefore, if sparse species are competitively superior, then their competitive abilities cannot be the reason for their low abundance. According to Rabinowitz, there are three characters which are responsible for rarity of species :

a. Geographical range

b. Habitat specificity

c. Local population.

Out of these 3 characters, any one of the character is small or narrow, we called those are rare species but the intensity of species diversity is different.

Large GR Wide HS Large LP	Large GR Wide HS Small LP	Large GR Narrow HS Large LP	Large GR Narrow HS Small LP
Small GR Wide HS Large LP	Small GR Wide HS Small LP	Small GR Narrow HS Large LP	Small GR Narrow HS Small LP

Fig.1 GR= Geographical Range; HS= Habitat Specificity; LP = Local Population

1st Box: Common species . eg. Brown Rat

8th Box: Rarest species. eg. Red Panda

3rd Box: eg. Mudskipper fish.

4th Box: Rarity is much moire intense. But rarity does not mean that they will become threatned as because rare species may be highly specialised one in small number in small area.

Threats to Biodiversity:

For most of modern history, human actions have proceeded without people giving much thought to the sustainability of ecosystems. These actions often include things that drastically alter the conditions in an ecosystem, such as draining wetlands, cutting down trees, and damming rivers. Sometimes, these actions threaten biodiversity within a community or ecosystem and on Earth as a whole. Recall that one measure of biodiversity is the variety of ecosystems on Earth. If human actions lead to the destruction of entire ecosystems, such as wetlands or rainforests, biodiversity on Earth could decrease. As scientists learn more about the effects of human actions on ecosystems, we are paying more attention to decreasing human impact on ecosystems and restoring ecosystems that have already been altered.

1. Overexploitation: Biodiversity is threatened when overexploitation occurs. Overexploitation is the use or extraction of a resource until it is depleted. Overexploitation can lead to dangerously low population numbers, if not the complete disappearance of a species. For example, the population of passenger pigeons was once about 5 billion. However, partly due to overhunting by early North American settlers, the last passenger pigeon died in the early 1900s. Overfishing of yellowfish tuna and Atlantic cod during the past few decades has reduced the numbers of these species by 90 percent. Now a days, sharks is an example of overexploitation. The sharks are killed for making fin soup in Euroope. Approximately, 200 million sharks are killed annually in the world. *Margaritifera auricularia*, is a fresh water mussel. Tgey are abundant in Europe and Africa. Tey have very shell. For collection of these shells, they are overexploited.

Introduction/ Allien species: Species introduced to new parts of the biosphere from other parts go by many names—alien species, introduced species, non-native species, and exotic species. Alien species may be released on purpose, but usually they arrive by accident in shipments of food and other goods. Most alien species are harmless or beneficial in their new environments. However, sometimes alien species are also invasive species. An invasive specie sis one that can take over the habitat of native species or invade their bodies. A native species is one that naturally inhabits an area. In many cases, invasive species upset the equilibrium of an ecosystem, causing problems for the native species. Many alien species invade aquatic ecosystems by way of cargo ships, particularly in ballast water. In order to increase their stability at sea, departing ships pick up water as ballast and hold it in tanks inside the hull. When they arrive at their destination, perhaps halfway around the world, the ballast water is dumped. Ballast water is like a giant aquarium, including microscopic organisms and fish. For eg. Zebra mussels are a species of freshwater mollusc that is native to Asia. They were introduced to the Great Lakes through ballast water in the 1980s. Since then, scientists have been monitoring the impact of this invasive species on the Great Lakes ecosystem. Zebra mussels, can out-compete native mussels and other native organisms in the lakes. One organism that has declined in number since the arrival of zebra mussels is a small, shrimp-like crustacean that shares the same food source as the zebra mussels. The crustaceans are a food source for many fish, including whitefish and smelt. As the number of these crustaceans has declined, so have the numbers of these fish. Scientists are studying more about the link between the arrival of zebra mussels and the decline of these organisms. Indian water is also under threats. *Clarias ganeoaenus* (Hybrid Magur) has been accidentally introduce in the Indian water. It is a very large fish and highly predator and its growth rate is very high. It predates on all aquatic biota. As a result, wherever, it introduced, all other species lives in the water, lossed. But, introduction of species also increase biodiversity. For eg. Forest region of Britain is devoid of any reptilian species but te niche of reptilian species is present. So, introduction of reptilian species also increase the biodiversity. Anoter example is of composite fish culture.

Habitat Loss/fragmentation:

Habitat loss occurs when events, due to natural disasters or human activities, alter a terrestrial or aquatic ecosystem so drastically that many species can no longer survive there. If the organisms cannot move somewhere else, or if no alternative habitat is available, species may not survive and biodiversity is threatened. Natural sources of habitat destruction are events such as volcanic eruptions, wildfires, droughts, and severe storms, such as hurricanes. Human activities that destroy habitats include deforestation, draining wetlands, and damming rivers.

Genetic Factors: This is the major problem for small population.

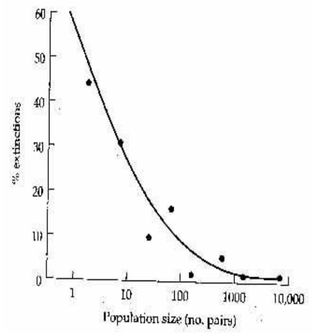


Figure 11.2 Extinction rates of bird species on the Channel Islands. Each dot represents the extinction percentage of all the species in that population size class; extinction rate decreases as the size of the population increases. Populations with less than 10 breeding pairs had an overall 39% probability of extinction over 80 years; populations of between 10 and 100 pairs averaged around 10% probability of extinction, and populations of over 100 pairs had a very low probability of extinction. (From Jones and Diamond 1976.)

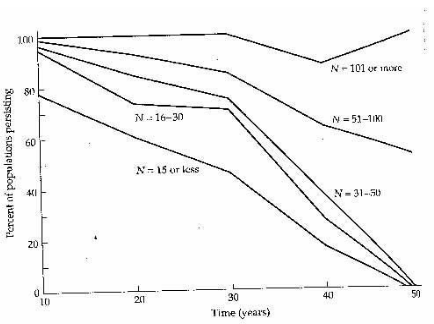


Fig: Population persistence of bighorn sheep in 70 years range.

Small population have inherent genetic errors in tem which is responsible for their extinction. 1. Genetic Drift and 2. Interbreeding depression. Of the initial population size is > 100, it can remain in equilibrium over 70 yaers although these may be lower the population size ------ more in the chance of extinction. A population must have a minimum viable population (MVP) or minimum genetically effective population size has to be maintained its population over generation

In a small population, there are some uncertainties like Demographic, Environmental and Spatial uncertainties which are also responsible for extinction of small population.

Demographic uncertainties: This is the ratio between male and female. If male is more, than reproduction is less. In small population it can hamper the population size. Beside this, there is also r selection strategy and k selection strategy. “r” means more biotic potential. For. Eg. Robin and “k” selection for large birds like Eagle.

Robin attains maturity at the age of 1+ years. Female of Robin lays eggs (6 eggs/spawning). It have high biotic potential but annual mortality rate is 74%.

In case of Eagle, it starts breeding at the age of 6+ years, fecundity is 3 eggs/female/spawning. But moratlity rate is low i.e. 50% mortality in 1^{st} year, 12.5% mortality from next year and so on. Suddenly, I 1^{st} year due to some environmental hazards, reproduction is hampered in both birds. In Robin, 25% persists but 75% die. In Eagle population, it declines only 12.5% which is very small (It will take about 5-6 years to make Eagle population half). If reproduction is allowed again, then Robin will recover fast but in case of Eagle, rate of recovery is low and rate of reproduction is also much less. So, it can be conclude that if, Eagle population is very low, then it can be recovered.

Environmental Uncertainties: In small population chance of survival is less

Quasi extinction: Prone to extinction but there is some chance of recovery is very little(if proper conservation is taken). A small population is very prone to become “0” or to a number which is so low that recovery is impossible.

Spatial Uncertainties: In a small population, chance of attack by predator is more in a small size of habitat but in case of large population- the chance is decreasing.

A **population bottleneck** (or genetic bottleneck) is a sharp reduction in the size of a population due to environmental events (such as earthquakes, floods, fires, disease, or droughts) or human activities (such as genocide). Such events can reduce the variation in the gene pool of a population; thereafter, a smaller population with a correspondingly smaller genetic diversity, remains to pass on genes to future generations of offspring through sexual reproduction. Genetic diversity remains lower, only slowly increasing with time as random mutations occur.[1] In consequence of such population size reductions and the loss of genetic variation, the robustness of the population is reduced and its ability to survive selecting environmental changes, like climate change or a shift in available resources, is reduced.

Conversely, depending upon the causes of the bottleneck, the survivors may have been the genetically fittest individuals, hence increasing the frequency of the fitter genes within the gene pool, while shrinking it. This genetic drift can change the proportional distribution of an allele by chance and even lead to fixation or loss of alleles. Due to the smaller population size after a bottleneck event, the chance of inbreeding and genetic homogeneity increases and unfavoured alleles can accumulate.

In population genetics, the **founder effect** is the loss of **genetic variation** that occurs when a new population is established by a very small number of individuals from a larger population. It was first fully outlined by Ernst Mayr in 1942,[1] using existing theoretical work by those such as Sewall Wright.[2] As a result of the loss of genetic variation, the new population may be distinctively different, both genotypically and phenotypically, from the parent population from which it is derived. In extreme cases, the founder effect is thought to lead to the speciation and subsequent evolution of new species

Genetic drift:

Genetic drift (also known as **allelic drift** or the **Sewall Wright effect** after biologist Sewall Wright) is the change in the frequency of a gene variant (allele) in a population due to random sampling of organisms. The alleles in the offspring are a sample of those in the parents, and chance has a role in determining whether a given individual survives and reproduces. A population's allele frequency is the fraction of the copies of one gene that share a particular form. Genetic drift may cause gene variants to disappear completely and thereby reduce genetic variation.

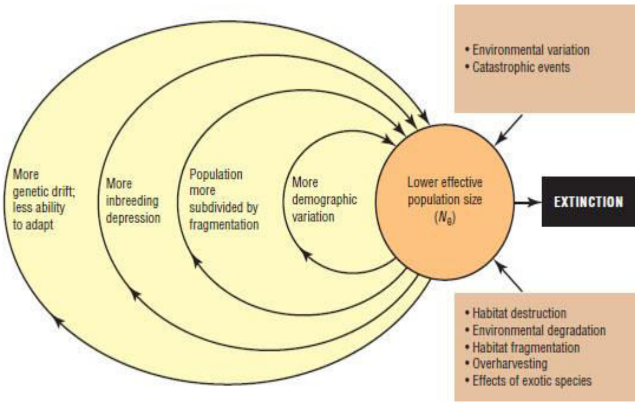
When there are few copies of an allele, the effect of genetic drift is larger, and when there are many copies the effect is smaller. The Hardy–Weinberg principle states that within sufficiently large populations, the allele frequencies remain constant from one generation to the next unless the equilibrium is disturbed by migration, genetic mutations, or selection.

However, in finite populations, no new alleles are gained from the random sampling of alleles passed to the next generation, but the sampling can cause an existing allele to disappear. Because random sampling can remove, but not replace, an allele, and because random declines or increases in allele frequency influence expected allele distributions for the next generation, genetic drift drives a population towards genetic uniformity over time. When an allele reaches a frequency of 1 (100%) it is said to be "fixed" in the population and when an allele reaches a frequency of 0 (0%) it is lost. Smaller populations achieve fixation faster, whereas in the limit of an infinite population, fixation is not achieved. Once an allele becomes fixed, genetic drift comes to a halt, and the allele frequency cannot change unless a new allele is introduced in the population via mutation or gene flow. Thus even while genetic drift is a random, directionless process, it acts to eliminate genetic variation over time.

Inbreeding is the production of offspring from the mating or breeding of individuals or organisms that are closely related genetically. By analogy, the term is used in human reproduction, but more commonly refers to the genetic disorders and other consequences that may arise from incestuous sexual relationships and consanguinity.

Inbreeding results in homozygosity, which can increase the chances of offspring being affected by recessive or deleterious traits. This generally leads to a decreased biological fitness of a population (called inbreeding depression), which is its ability to survive and reproduce. An individual who inherits such deleterious traits is referred to as *inbred.* Offspring of biologically related persons are subject to the possible effect of inbreeding, such as congenital birth defects. The chances of such disorders are increased when the biological parents are more closely related. (See coefficient of inbreeding.) This is because such pairings have a 25% probability of producing homozygous zygotes, resulting in offspring with two recessive alleles, which can produce disorders when these alleles are deleterious. Because most recessive alleles are rare in populations, it is unlikely that two unrelated marriage partners will both be carriers of the same deleterious allele. However, because close relatives share a large fraction of their alleles, the probability that any such deleterious allele is inherited from the common ancestor through both parents is increased dramatically. It should also be noted that, in terms of probability, for each homozygous recessive individual formed, there is an equal chance of producing a homozygous dominant individual, one completely devoid of the harmful allele. Contrary to common belief, inbreeding does not in itself alter allele frequencies, but rather increases the relative proportion of homozygotes to heterozygotes. However, because the increased proportion of deleterious homozygotes exposes the allele to natural selection, in the long run its frequency decreases more rapidly in inbred populations. In the short term, incestuous reproduction is expected to increase the number of spontaneous abortions of zygotes, perinatal deaths, and postnatal offspring with birth defects.

EXTINCTION VORTEX MODEL BY PRIMACK(1993):



THEORIES EXPLAINING GLOBAL BIODIVERSITY VARIATION:

1. The Productivity Hypothesis:

i. Correlation between high diversity ad high production seems obvious on a global scale i.e.- Tropical rain forests are richly productive and highly diverse. The barren Tundra of Arctic or mountain tops have comparatively few species.

ii. Energy supplies determine the size of populations: Then question is why therefore, energy should not also determine a limit to species richness?

iii. Actually high productivity should mean a larger total population of individuals and hence the chance to divide the available energy among more species populations. More energy for plants can mean dense local population of the kind required to promote between habitat diversity and this diversity provides a diversity of niche for animals. Therefore, high productivity means high amount of available energy in an area, that ultimately determine species richness.

Less movement of animals for the seed dispersal   Greater isolation between plants & Animals

iv. Stable environment--- Less energy for maintenance---More energy for reproduction---Large population---

Greater chance to utilise various resources

Greater genetic diversity--- More chances to exist over wide area---More chance of isolation---Greater chance of speciation---More species---Community stability

a. In an stable environment , genetic diversity is greater, tis enables members of a population to survive in new environment- this leads to geographical separation followed by reproductive isolation and speciation.

b. If more energy is utilised for reproduction, less energy utilised for movement, so animal shows little movement for seed dispersal leading to sympatric speciation.

Exceptions:

a. In arid land pastures, the species richness particularly of plants is quite high.

b. The record of the deep sea directly conflicts with the productivity hypothesis because diversity of fauna is quite high in extremely unproductive abyssal bottom.

2. Habitat Structure Hypothesis:

i. Gradient of the habitat always influences the species diversity. The habitat gradient index is a function of vegetation height and density.

ii. A study from grassland to shrub land to woody areas of Southern Chile, Africa and California by Cody (1975) revealed that with increase of habitat gradient index, the species diversity of birds also increases.

Chile---California---Africa

iii. In tropical rain forest, the complex vegetation leads to spatial multiplication for animal niche. Mac Arthur (1965)- proposed an idea that the extra layer of canopy in tropical forests accounts for the larger number of bird species- therefore, bird species diversity may be taken as a reference to measure the relative layering forest.

iv. Exceptions- For animals other than birds, structure seems less important. i.e. In Panamanian forest canopies of a single species of tree contain 1200 species of beetle. Therefore, more structural diversity could not attribute diversity of such unthinkable scale.

3. Greater Array of Guild Hypothesis:

i. If the resource is continuous, then it is renewable and can support the different dependent species.

ii. So, due to huge and continuous resources, aggregation of different species with similar mode of function occurs within a particular area, this ultimately leads to formation of new guilds within that area.

iii. Ex: In tropical rain forest, the guilds of primates, fruit eating bats and fruit eating birds like hornbills or toucans exist, coevolved to the need of forest trees to have their progeny dispersed. Other primates and mammal guilds are present as arboreal herbivores; and this canopy life supports guilds of canopy haunting predators like monkey eating eagles.

4. The Rejuvenating Catastrophe Hypothesis:

i. Alfred Russel Wallace (1878) put forward this hypothesis. According to this, species of the high latitudes follows ice age extinctions. Glaciers scraped northerly land masses causing extinction of moist of the species. The temperate belt south of the ice suffered massive climatic changes and extinction also. After that, only 10000 years have been available within which complete recovery is not possible. Therefore, the observed latitudinal cline is natural consequences.

Merits: This theory explains how forest habitats in Europe were almost eliminated as Central Europe was squeezed between the Fenoscandian ice sheet and glaciers in the Alps. Thus the theory argues Europe lost many of the key species i.e. (Liriodendron or tulip tree, liquidamber or sweet gun) from its old tertiary forest because of this reduction of forest habitat with each successive ice age.

Objections: i. The maintenance of latitudinal cline in all ecological epochs, those without ice age as well as those with them is not possible.

5. Time Stability Hypothesis:

i. This hypothesis states that – species diversity of a habitat depends upon- a. the time over which the habitat is in existence

b. also its physical stability.

ii. The dark energy starving floor of deep sea shows no environmental variations; same environment exists here far about 100 million years, so it represents the most stable environment. In deep sea floor –the population do not fluctuate, so their extinction rate is very low- for this, species diversity in deep sea is very high.

iii. The estuaries and continental shelves show a wide environmental changes- both seasonal and catastrophic; so extinction rate is high here with a minimum number of stable species. For, this species diversity is also very low here.

Demerits: The tropical rain forest, on this hypothesis, acquired their huge species diversity because the absence of physical calamity ensured that no species ever became extinct. But actually the equatorial regions have both weather and season and their communities are in continual change with coming and going of the ice ages- thus the Time stability hypothesis lost its generality and appeal.

6. The Latitude Area Effect Hypothesis:

i. High climatic variation has an adverse effect upon the species diversity.

ii. The spherical shape of earth ensures that the actual land area on equatorial countries is large. Now, the equatorial region provides a large habitat almost with stable climatic condition i.e.- little or no climatic changes occur when migrated 5^0 N/S of the equator. In northern and southern hemisphere, slight variation in latitude cause drastic changes in climatic condition i.e. – only 3 degrees of latitude separates northern France from the Mediterranean Sea, embracing massive climatic change.

Therefore, species diversity is also high in larger equatorial area with uniform climate than areas of high latitude.

7. The Intermediate Disturbance Hypothesis:

i. This hypothesis states- disturbance that are not so severe to cause extinction of a species, but sufficient enough to disrupt the completion between different species, is termed as intermediate disturbance. This is helpful to maintain a high species diversity.

ii. For example- In tropical rain forest, the trees grow quickly due to warmth, moisture and prolonged growth period. But due to dependence of surface litter, they develop shallow root system. Now climbing plants, creepers, various animals including birds reside upon the plant to impose a great load upon it. Under this condition, the tree may be toppled down by frequent thunder storms leading to destruction together with associated plants.

Merits: This hypothesis explains, instead of huge production a. why tropical rain forest is not a simple system like polluted estuary? And Why tropical rain forests have a higher diversity than others.